APPENDIX G

REGULATORY ANALYSIS

This page intentionally left blank.

CONTENTS

TABLES

LIST OF TERMS

ILCR	incremental lifetime cancer risk
RCRA	*Resource Conservation and Recovery Act of 1976*
WMA	waste management area

G.1.0 INTRODUCTION

Phase 1 RCRA Facility Investigation/Corrective Measures Study Work Plan for Single-Shell Tank Waste Management Areas (DOE-RL 2000) provides the regulatory framework for the *Resource Conservation and Recovery Act of 1976* (RCRA) Corrective Action Program. This regulatory framework is based on federal statutes and regulations, Washington State statutes and regulations, the *Hanford Federal Facility Agreement and Consent Order* (HFFACO; Ecology et al. 1989); and the Hanford Site RCRA Permit (Ecology 2001). Applicable or relevant and appropriate requirements are provided in Appendix F of DOE-RL (2000).

The purpose of a field investigation report is to summarize data from a waste management area (WMA) investigation and evaluate the data to the extent necessary to determine the need for immediate action through interim measures or accelerated interim corrective measures at the WMA. At a minimum, the data is evaluated to determine the potential risk associated with hypothetical exposure to soil and groundwater at the WMA boundary as described in Section 4.0 of DOE-RL (2000). If the potential near-term risk to human health is excessive, the U.S. Department of Energy and Washington State Department of Ecology may propose one or more interim measures to mitigate the risk or may initiate an accelerated corrective measure study to evaluate and compare more complex interim corrective measures.

The evaluation of the risks associated with existing contamination serves several purposes. Some of these purposes include the following:

- Establish the need for additional interim measures or interim corrective measures
- Provide necessary input to Hanford Site-wide cumulative risk assessments
- Serve as a basis to begin identifying cleanup standards for closure.

Cleanup standards are based on both regulatory requirements and the potential risk to human health and the environment. The potential risk depends in part on the hypothetical exposure scenario, which in turn depends on the assumed land use (including surface water and groundwater). Exposure and land use scenarios are also important in identifying the appropriate regulatory requirements for cleanup. For example, the determination of cleanup standards under the "The Model Toxics Control Act Cleanup Regulation" (WAC 173-340) depends on whether an unrestricted (residential) or industrial scenario is applied, and the use of alternate concentration limits under "Concentration Limits" (WAC 173-303-645(5)) depends in part on future groundwater uses. In 1999, the U.S. Department of Energy issued *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement* (DOE 1999), which used the *National Environmental Policy Act of 1969* process to evaluate several land uses for the Hanford Site planned over the next 50 years. That environmental impact statement and associated record of decision "Hanford Comprehensive Land-Use Plan Environmental Impact Statement (HCP EIS), Hanford Site, Richland, Washington; Record of Decision (ROD)" (64 FR 61615), identify 'industrial-exclusive use' as the planned use for the 200 Areas Central Plateau, an area that encompasses the 200 East and 200 West Areas. The Washington State Department of Ecology is evaluating how the U.S. Department of Energy land-use planning efforts fit within the Washington State Department of Ecology cleanup framework; the agency has not agreed at this time to an industrial use scenario. Therefore, potential risk and the regulatory requirements for establishing media cleanup standards for the RCRA Corrective Action Program cannot be

finalized. Appendix E of this report presents the risk assessment and evaluation approach and results that considers several potential exposure scenarios identified in DOE-RL (2000).

G.2.0 REGULATORY PERFORMANCE MEASURES

Table G.1 identifies quantitative performance measures for various constituents, including hazardous and radiological contaminants. The level of protection established by the standards is expressed in terms of the maximum dose or contaminant concentration under various exposure scenarios. Each standard, therefore, reflects the determination by the regulatory agency of an appropriate level of protection that should be provided to protect human health. Generally, the spectrum of regulations reflected in Table G.1 demonstrates that the level of protection provided by regulatory agencies is consistent among the regulations whether they apply to dangerous contaminants (e.g., chemicals and metals) or radiological contaminants. The level of protection provided under the regulations ranges from between 1 incremental lifetime cancer risk (ILCR) in 10,000 (1.0×10^{-4}) and 1 in 1,000,000 (1.0×10^{-6}) on an annual basis.

The most important regulations related to this WMA S-SX field investigation report are those addressing cleanup of soils and groundwater and the associated risk or dose to human health through the groundwater exposure pathway. The following sections discuss compliance with the applicable regulations.

Table G.1. Regulatory Performance Measures

Regulation	Requirement		Performance Measure	Point-of-Compliance	Notes
DOE Order 5400.5	**Protection of the general public and environment.**				
Protection of the Public	All pathways for LLW except air (mrem/yr)		25	100 m downgradient for groundwater, at waste site for direct exposure	100 years of institutional control.
	All pathways including other Hanford sources per 10 CFR 20, DOE Order 5400.5 and DNFSB 94-2 (mrem/yr)		100	100 m downgradient for groundwater, at waste site for direct exposure	--
Protection of Groundwater (40 CFR 141)	Beta/proton emitters (mrem/yr)		4	100 m downgradient	100 years of institutional control. 500 years of passive control. 10,000 years for impacts analysis. Assumes water ingestion of 2 L/day. Alpha emitters: 15 pCi/L = 40 mrem/yr radon: 3 pCi/L = 20 mrem/yr
	Alpha emitters (pCi/L)		15		--
40 CFR 141 and DOE Order 5400.5	**Drinking water standards for select constituents with the potential for release to groundwater during operations, retrieval actions, or postclosure**				
MCLs and derived concentration guide for select constituents **Source: 40 CFR 141**	H-3	20,000 pCi/L		Drinking water source	1,000 yr for compliance analysis. Alpha Emitters: 15 pCi/L = 40 mrem/yr.
	C-14	2,000 pCi/L			
	I-129	1 pCi/L			
	U	0.02 mg/L (Total)			
	Tc-99	900 pCi/L			
	Cs-137	200 pCi/L			
	NO_3	45 mg/L			
	Cr	0.5 mg/L			

LLW = low-level waste.
MCL = maximum contaminant level.

G.3.0 REGULATORY COMPLIANCE FROM FIELD DATA

Regulatory compliance data for soils and groundwater collected during the field investigation activities are presented with comparison to regulatory requirements in Appendices B and C. The following sections discuss the new WAC 173-340 revision related to assessing derived soil concentrations for groundwater protection, "Deriving Soil Concentrations for Ground Water Protection" (WAC 173-340-747), and groundwater contamination present in WMA S-SX groundwater monitoring.

G.3.1 SOIL DATA

Under WAC 173-340-747 the term 'soil concentration' means the concentration in the soil that will not cause an exceedance of the groundwater cleanup level established under "Ground Water Cleanup Standards" (WAC 173-340-720). Six different methodologies can be used to determine if the criterion has been met. This WMA S-SX field investigation report uses the alternative fate and transport model (WAC 173-340-747(8)). The values used in the fate and transport modeling are based on best estimates and do not comply with the default values in WAC 173-340-747. The values used provide an estimate of groundwater impacts from the soil inventory estimate (see report main text Sections 3.3 and 4.2 and also Appendix E). Numerical simulation results are obtained on long-term transient contaminant concentrations at the water table and for compliance at the WMA boundary, 200 West fence boundary, 200 Area exclusion boundary, and the shoreline at the Columbia River. These compliance points are based on DOE-RL (2000). However, since the 200 Area and exclusion boundaries are relatively close, the 200 Area boundary is replaced by the 200 West fence boundary. For vadose zone modeling, three representative (west-east) cross-sectional models for the S and SX tank farms were considered:

- Cross-section through tanks, S-106, S-105, and S-104 (S-CC')
- Cross-section through tanks SX-109, SX-108, and SX-107 (SX-DD')
- Cross-section through tanks SX-115, SX-114, and SX-113 (SX-FF').

Table G.2 provides the case numbers and descriptions for the numerical simulations as discussed in Section 4.0 of the main text and Appendix E. Numerical results are obtained on long-term transient contaminant concentrations and at compliance boundaries for each cross-section at WMA S-SX (i.e., cross-sections S-CC', SX-DD' and SX-FF'); 200 West fence; 200 Area exclusion boundary; and the Columbia River shoreline (DOE-RL 2000).

The groundwater concentration values based on inventory show that for the three cross-sections analyzed (i.e., S-CC', SX-DD', and SX-FF'), drinking water standards (40 CFR 141) will be exceeded. Tables G.3 and G.4 list the predicted technetium-99, chromium, and nitrate levels and the associated 40 CFR 141 limits. Table G.3 lists the groundwater concentration values for three cross-sections at the WMA S-SX boundary. Table G.4 lists the groundwater concentration values for the 200 West fence, 200 Area exclusion boundary, and the Columbia River shoreline.

Table G.2. Case Descriptions for the Two-Dimensional Simulations

Case No.	Description*	Interim Barrier	Inventory Distribution	Meteoric Recharge (mm/yr)
1	Base case (no action alternative)	No	Uniform	100
2	Barrier alternative	Yes	Uniform	100
3	Water-line leak (25,000 gal)	No	Uniform	100
4	Clastic dike	No	Uniform	100
5	Nonuniform inventory	No	Nonuniform	100
6	Nonuniform inventory with barrier	Yes	Nonuniform	100
7	Displaced nonuniform barrier	No	Displaced	100
8	Density and viscosity effects	No	Uniform	100
9	Base case with 50% recharge	No	Uniform	50
10	Base case with 30% recharge	No	Uniform	30
11	Base case with 10% recharge	No	Uniform	10
12	Alternative inventory	No	Alternate	100
13	Water-line leak (200,000 gal)	No	Uniform	100

*See Appendix E, Section E.2.1 for details on each case.

Table G.3. Modeled Groundwater Concentrations (Average Weighted) at the Waste Management Area S-SX Boundary

Cases	Waste Management Area S-SX Boundary								
	S-CC*			SX-DD*			SX-FF*		
	Technetium-99 (pCi/L)	Chromium (μg/L)	Nitrate (μg/L)	Technetium-99 (pCi/L)	Chromium (μg/L)	Nitrate (μg/L)	Technetium-99 (pCi/L)	Chromium (μg/L)	Nitrate (μg/L)
Case 1	108,303	2,213	664,506	968,367	81,051	1,013,000	225,324	3,564	795,585
Case 2	72,309	406	450,727	144,430	7,558	684,500	158,646	677	537,589
Case 3	NA	NA	NA	NA	NA	1,018,000	224,774	3,585	799,512
Case 4	NA	NA	NA	963,655	80,265	NA	NA	NA	NA
Case 5	1,397,182	30,410	6,216,243	4,263,016	352,241	4,382,000	2,063,180	28,391	3,441,513
Case 6	970,724	5,189	4,435,798	680,842	37,588	3,339,000	1,570,750	6,073	2,622,367
Case 7	4,519,048	52,149	19,218,126	9,102,496	599,477	13,100,000	5,721,457	50,044	10,288,413
Case 8	109,403	2,214	670,553	989,573	82,621	1,024,000	228,151	3,570	804,224
Case 9	72,522	704	446,721	294,044	17,443	713,500	156,133	1,297	560,365
Case 10	40,989	237	256,661	87,491	5,692	432,400	96,837	464	339,596
Case 11	8,301	126	53,555	53,209	3,265	98,950	21,857	246	77,713
Case 12	105,711	2,090	470,283	459,994	34,973	513,700	245,979	3,007	403,447
Case 13	NA	NA	NA	NA	NA	952,200	192,024	3,395	747,834
Regulatory Standard	**900 pCi/L**	**50 μg/L**	**45,000 μg/L**	**900 pCi/L**	**50 μg/L**	**45,000 μg/L**	**900 pCi/L**	**50 μg/L**	**45,000 μg/L**

*Groundwater concentrations given are the breakthrough values for the cross-sections. See Appendix E.

Table G.4. Modeled Groundwater Concentrations (Average Weighted) at Specified Compliance Points

Cases	200 West Area Fence			200 Area Exclusion Boundary			Columbia River Shoreline		
	Technetium-99 (pCi/L)	**Chromium (µg/L)**	**Nitrate (µg/L)**	**Technetium-99 (pCi/L)**	**Chromium (µg/L)**	**Nitrate (µg/L)**	**Technetium-99 (pCi/L)**	**Chromium (µg/L)**	**Nitrate (µg/L)**
Case 1	4,890	449	9,490	380	34.9	737	128	11.9	249
Case 2	1,910	85.5	4,310	147	6.44	334	51.1	2.31	115
Case 3	4,890	452	9,500	379	35.1	738	129	12.0	250
Case 4	4,890	447	9,460	379	34.8	735	128	11.8	249
Case 5	5,290	523	10,200	411	40.8	796	139	13.8	269
Case 6	2,090	103	4,800	162	7.76	373	56.1	2.77	129
Case 7	6,890	778	13,100	542	60.9	1,030	178	20.2	339
Case 8	4,960	455	9,610	385	35.4	747	130	12.0	252
Case 9	2,500	154	5,320	191	11.7	409	66.7	4.14	142
Case 10	1,320	55.5	3,040	99.7	4.11	231	35.4	1.50	81.7
Case 11	308	7.27	745	22.6	0.513	54.8	8.28	0.189	20.1
Case 12	4,950	451	9,630	384	35.1	748	130	11.9	253
Case 13	4,760	455	9,420	368	35.3	730	125	12.0	248
Regulatory Standard	**900 pCi/L**	**50 µg/L**	**45,000 µg/L**	**900 pCi/L**	**50 µg/L**	**45,000 µg/L**	**900 pCi/L**	**50 µg/L**	**45,000 µg/L**

The predicted groundwater concentrations exceed the regulatory standards at the WMA and for most of the cases at the 200 West fence boundary. Exceedances of the groundwater maximum contaminant levels occur for all three modeled constituents at the WMA S-SX boundary (Table G.3). At the 200 West Area fence, nitrate and chromium for Case 11 did not exceed the groundwater maximum contaminant levels (Table G.4). At the 200 Area exclusion boundary (i.e., the rest of the Central Plateau including 200 Area North extending north to the base of Gable Butte), nitrate and technetium-99 did not exceed the groundwater maximum contaminant levels for any of the cases along with chromium except for Case 7 (Table G.4). At the Columbia River shoreline, no constituent exceeded the groundwater maximum contaminant levels for any of the cases (Table G.4).

G.3.2 GROUNDWATER DATA

Based on *Hanford Site Groundwater Monitoring for Fiscal Year 2000* (Hartman et al. 2001) groundwater monitoring well data for the RCRA groundwater wells associated with WMA S-SX indicate the following constituents have exceeded the 40 CFR 141 drinking water standards during fiscal year 2000:

- Antimony
- Carbon tetrachloride
- Gross alpha
- Gross beta
- Nitrate
- Nitrite
- Technetium-99
- Tritium
- Uranium.

Table G.5 provides the RCRA groundwater monitoring well exceedances for the various constituents and the number of exceedances that have occur for the fiscal year.

Groundwater monitoring well 299-W23-19 is located inside the SX tank farm and was constructed under the RCRA facility investigation conducted in June 1999.

Table G.5. Groundwater Monitoring Results Exceeding Maximum Contaminant Levels or Drinking Water Standards at Waste Management Area S-SX

Well Number	Antimony (μg/L)	Carbon Tetrachloride (μg/L)	Gross Alpha (pCi/L)	Gross Beta (pCi/L)	Nitrate (μg/L)	Nitrite (μg/L)	Technetium-99 (pCi/L)	Tritium (pCi/L)	Uranium (μg/L)
299-W22-39	NA	NA	NA	NA	NA	NA	NA	28,500 (3)	NA
299-W22-44	42.8 (1)	8.6 (5)	NA	NA	NA	NA	NA	NA	NA
299-W22-45	NA	12 (3)	NA	768 (3)	47,366.76 (2)	NA	2,080 (3)	NA	NA
299-W22-46	26.4 (1)	30 (3)	NA	1,830 (3)	45,596.04 (1)	NA	5,330 (3)	26,400 (3)	NA
299-W22-48	NA	5.6 (1)	NA	555 (2)	NA	NA	1,290 (1)	NA	NA
299-W22-49	44.3 (1)	6 (2)	NA	NA	NA	NA	NA	23,900 (3)	NA
299-W22-50	88.6 (1)	23 (5)	20.9 (1)	1,420 (4)	57,991.08 (1)	NA	4,240 (3)	31,400 (3)	NA
299-W23-1	NA	25 (1)	NA	110 (1)	NA	NA	NA	NA	NA
299-W23-13	30 (1)	11 (2)	NA	NA	NA	NA	NA	NA	NA
299-W23-14	NA	NA	NA	NA	134,574.7 (1)	NA	NA	208,000 (1)	NA
299-W23-15	NA	140 (3)	NA	NA	NA	NA	NA	NA	NA
299-W23-19	NA	30 (4)	NA	23,000 (4)	562,203.6 (6)	5,485.18 (4)	72,000[a] (6)	95,800 (4)	23.6 (1)
299-W23-4	NA	130 (3)	NA	NA	NA	NA	NA	NA	25.3 (3)
299-W23-9	31.7 (1)	NA	NA	56.6 (1)	165,562.3 (3)	NA	NA	502,000 (3)	20.5 (1)
DWS or MCL	6	5	15	50	45,000	3,300	900	20,000	20

Notes: **Bold** indicates an upgradient groundwater monitoring well. Number indicates the maximum result for that well during the monitoring period from October 1, 1999 to September 30, 2000. Parenthesis indicates the number of exceedance in the particular well. These are the results taken in March 2001.

DWS = drinking water standard (40 CFR 141).
MCL = maximum contaminant level.
NA = well did not exceed MCLs for the constituent.

G.4.0 HUMAN HEALTH RISK AND DOSE RESULTS COMPARISON TO REGULATIONS

As presented in main text Section 4.0 and in Appendix E, the peak ILCR, hazard index, and dose for the industrial worker scenario is used as the baseline for comparison purposes. The results indicate that for all compliance points at the WMA S-SX boundary the ILCR, hazard index, and dose exceed regulatory standards of 10^{-5}, 1.0, and 4 mrem/yr, respectively (Table G.6).

The ILCR exceeds the regulatory standard of 10^{-5} for all the cross-sections at the WMA S-SX boundary and Cases 1, 2, 5, 9, and 10 at the 200 West Area fence boundary. Based on current groundwater concentrations of technetium-99 in RCRA groundwater well 299-W23-19, the ILCR would be 5.1×10^{-3} for the industrial worker scenario. The regulatory standard is 1.0×10^{-5} (Table G.6).

The hazard index exceeds the regulatory standard of 1.0 for Case 1 at the WMA S-SX boundary and 200 West fence boundary compliance points. Cases 2, 9, 10, and 11 exceed the hazard index regulatory standard of 1.0 at WMA S-SX boundary (Table G.6).

Dose exceeds the regulatory standard of 4 mrem/yr for beta/photon emitters for Cases 1, 2, 9, 10, and 11 at the WMA S-SX boundary (Table G.6).

Table G.6. Comparison of Peak Incremental Lifetime Cancer Risk, Hazard Index, and Dose for the Industrial Worker Scenario

Case	WMA S-SX Boundary			200 West Fence	200 Area Exclusion Boundary	Columbia River Shoreline
	S-CC'	SX-DD'	SX-FF'			
Industrial Worker Peak Incremental Lifetime Cancer Risk						
1	1.15E-03	9.98E-03	2.34E-03	5.07E-05	3.94E-06	1.33E-06
2	7.68E-04	1.49E-03	1.65E-03	1.98E-05	1.53E-06	5.30E-07
9	7.70E-04	3.03E-03	1.62E-03	2.59E-05	1.99E-06	6.92E-07
10	4.36E-04	9.02E-04	1.01E-03	1.36E-05	1.03E-06	3.67E-07
11	8.82E-05	5.49E-04	2.27E-04	3.19E-06	2.35E-07	8.59E-08
Industrial Worker Peak Hazard Index						
1	1.16E+01	3.00E+02	1.96E+01	1.60E+00	1.24E-01	4.22E-02
2	5.35E+00	2.99E+01	9.77E+00	3.25E-01	2.45E-02	8.79E-03
9	6.29E+00	6.73E+01	1.19E+01	5.63E-01	4.29E-02	1.52E-02
10	3.08E+00	2.07E+01	6.30E+00	2.11E-01	1.57E-02	5.69E-03
11	7.67E-01	1.25E+01	1.43E+00	2.81E-02	2.04E-03	7.54E-04
Industrial Worker Peak Dose (mrem/yr)						
1	6.91E+01	5.94E+02	1.40E+02	3.02E+00	2.35E-01	7.94E-02
2	4.61E+01	8.86E+01	9.85E+01	1.18E+00	9.10E-02	3.16E-02
9	4.63E+01	1.80E+02	9.69E+01	1.54E+00	1.18E-01	4.13E-02
10	2.61E+01	5.37E+01	6.01E+01	8.14E-01	6.17E-02	2.19E-02
11	5.29E+00	3.26E+01	1.36E+01	1.90E-01	1.40E-02	5.12E-03

G.5.0 REFERENCES

10 CFR 20, "Standards for Protection Against Radiation," *Code of Federal Regulations*, as amended.

40 CFR 141, "National Primary Drinking Water Regulations," *Code of Federal Regulations*, as amended.

64 FR 61615, 1999, "Hanford Comprehensive Land-Use Plan Environmental Impact Statement (HCP EIS), Hanford Site, Richland, Washington; Record of Decision (ROD)," *Federal Register*, Vol. 64, No. 218, pp 61615, November 12.

DNFSB 94-2, 1994, *Recommendation 94-2 to the Secretary of Energy*, Defense Nuclear Facilities Safety Board, Washington, D.C.

DOE Order 5400.5, 1993, *Radiation Protection of the Public and Environment*, U.S. Department of Energy, Washington, D.C.

DOE, 1999, *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement*, DOE/EIS-0222F, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 2000, *Phase 1 RCRA Facility Investigation/Corrective Measures Study Work Plan for Single-Shell Tank Waste Management Areas*, DOE/RL-99-36, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Ecology, 2001, *Dangerous Waste Portion of the RCRA Permit for the Treatment, Storage, and Disposal of Dangerous Waste Hanford Site-Wide Permit*, Rev. 7, Washington State Department of Ecology, Olympia, Washington.

Hartman, M. J., L. F. Morasch, and W. D Webber, *Hanford Site Groundwater Monitoring for Fiscal Year 2000*, PNNL-13404, Pacific Northwest National Laboratory, Richland, Washington.

National Environmental Policy Act of 1969, 42 USC 4321 et seq.

Resource Conservation and Recovery Act of 1976, Public Law 94-580, 90 Stat. 2795, 42 USC 901 et seq.

WAC 173-340, "The Model Toxics Control Act Cleanup Regulation," *Washington Administrative Code*, as amended.

WAC 173-303-645(5), "Concentration Limits," *Washington Administrative Code*, as amended.

WAC 173-340-747, "Deriving Soil Concentrations for Ground Water Protection," *Washington Administrative Code*, as amended.

WAC 173-340-747(8), "Alternative Fate and Transport Models," *Washington Administrative Code*, as amended.

WAC 173-340-720, "Ground Water Cleanup Standards," *Washington Administrative Code*, as amended.